AD-A135 553 SOVIET MARINE PROPULSION PLANTS (SOWJETISCHE SCHIFFSANTRIEBANLAGEN)(U) NAVAL INTELLIGENCE SUPPORT CENTER WASHINGTON DC TRANSLATION DIV L STOLL 07 NOV 83 1/1

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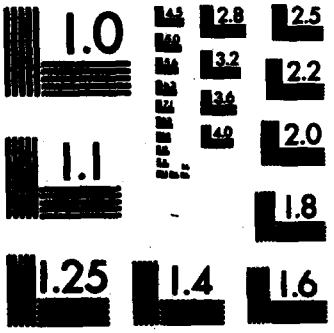

NAVAL INTELLIGENCE SUPPORT CENTER

TRANSLATION DIVISION NISC-62
4301 Suitland Road
Washington, D.C.

TRANSLATION

TITLE: SOVIET MARINE PROPULSION PLANTS

SOWJETISCHE SCHIFFSANTRIEBANLAGEN

AUTHOR: LUDWIG STOLL

TRANSLATED BY: 9197

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SOVIET MARINE PROPULSION PLANTS

(Stoll, Ludwig; "Sowjetische Schiffsantriebanlagen;" Schiff & Hafen/Kommandobruecke, Vol. 35, No. 7, 1983; pp. 39-45; German).

Superficially, the Soviet merchant and fishing fleet (now swollen to over 26 million gross tons) uses much the same propulsion techniques as any other. About 95 percent of all vessels use diesels. Among the engine builders, the emphasis is on large, slow-revving diesels. Noticeable attempts are also being made to achieve economy with the use of cheap fuels. (39*

Automation, as everywhere, is gaining importance (according to the ship register of the USSR, there are two grades of automation: A 1 for a watch-free engine room, and A 2 for a single-watchstander operation). Likewise, the employment of maneuvering aids such as active rudders and transverse thrusters has become routine. Yet to be mentioned as a modern propulsion system is waterjet propulsion used on some hydrofoils. Controllable-pitch propellers are in wide use, and are also manufactured for high-performance propulsion. According to statements in the Soviet trade literature, about 2,700 controllable-pitch arrangement of domestic manufacture alone have been installed.

On closer inspection, yet additional details and trends are discernable. The USSR energetically promotes the development and deployment of nuclear-propelled ships. Whereas the American "Savannah" and the German "Otto Hahn" have been out of service for a long time, the Soviet Union not only continues the construction of a series of nuclear-propelled icebreakers, but also of large freighters with nuclear propulsion. Evidently, great importance is attached to the employment of nuclear-propelled ships in arctic waters, and commensurate benefits are anticipated. A further variant is gas turbine propulsion. Whereas the latter have lost some importance in the West compared with the economical diesel engine at a time of rising fuel costs, the Soviet Union developed a special type of gas turbine that is presumably not only being considered for fast Ro/Ro ships, but may also be of interest in warship construction.

Other than analysis of facts and development trends, the question arises to what extent Soviet technology in the area of marine propulsion plants meets international standards, whether it has possibly even exceeded those, or if alternatively, a technological backwardness is noticeable. The Soviet trade

* Numbers in the right margin indicate pagination in the original text.

literature and official announcements are, as is well-known, of little informative value on this matter. Consequently, firm judgments and facts must be brought to bear along with interpretations and opinions.

Conventional Steamplants and Nuclear Propulsion

The proportion of steam-driven seagoing ships has shrunk steadily in the USSR as well. High-powered steam turbine plants are presently still found almost exclusively on board the older series of tankers and passengers ships of foreign origin, e.g., the "Maxim Gorky" (ex-"Hamburg"). In recent years, only the 150,000 deadweight ton "Krim" class tankers were registered as steam-propelled new-construction. The boiler design on these ships generates 78.5 tons of steam per hour with a pressure of 78 kiloponds per square centimeter, and a temperature of 510 degrees Celcius. (Translator's Note: one kilopond is the technical equivalent of one kilogram). The turbines deliver an output of 23,530 kilowatt (32,000 horsepower) onto a four-bladed bronze controllable-pitch propeller that weighs 50 tons with a diameter of 7.5 meters. The manufacturer is the "Proletarskiy Savod" enterprise in Leningrad. The combined steam turbine-controllable-pitch propeller is all the more remarkable since, with the new gas turbine plant, for example, Soviet designers have preferred reverse gearing in place of the use of controllable-pitch propellers.

A typical example of a nuclear plant is that of the "Arktika" class of icebreakers ("Arktika" has in the meantime been renamed "Brezhnev"). The steam that is generated by two reactors drives two turbines of 275,000 kilowatts each (37,500 horsepower) which, in turn, drive three generators each that deliver electricity for three propeller engines. At issue therefore is nuclear turbo-electric propulsion.

A plant that diverges from this principle is exemplified by the atomic propulsion of the new class of LASH-ships that are conceived for employment in arctic waters, and that have icebreaking characteristics. The ships of about 61,000 tons displacement and 260 meters length are to transport 74 LASH-type lighters. The propulsion plant is divided into a reactor- and boiler-engine zone. The reactor plant generates 215 tons of steam per hour with a pressure of 39 kiloponds per square centimeter, and a temperature of 290 degrees Celcius. The turbine plant consists of a seven-stage high-pressure-, and an eight-stage low-pressure turbine. The output of 29,400 kilowatts (40,000 horsepower) is transmitted to a controllable-pitch propeller that is protected against icing by a jet nozzle. The steam is transmitted via the usual cycle. The maximum attainable speed is supposed to amount to 22 knots.

In the event that the reactor must be shut down, an oil-fired auxiliary boiler is available that can generate 50 tons

of steam per hour at a pressure of 24 kiloponds per square centimeter and a temperature of 356 degrees Celcius, and that can be fed into the steam cycle.

Using this emergency circuit, an output of 4,780 kilowatts (6,500 hp) can be accomplished. The idea for this propulsion plant may also have been behind the equipment on the cruiser "Kirov" that - notwithstanding clearly noticeable and large exhaust intakes - professional circles first thought to be a ship with pure nuclear propulsion.

Diesel Engines.

Regarding the employment and construction of maritime diesel engines in the USSR, the American expert Anthony C. Sutton of Stanford University (see source references) wrote an equally informative as well as sensational study that culminated in the following conclusions:

1. Not only the predominant portion of Soviet shipping tonnage is of foreign origin, but so is the bulk of propulsion engines.
2. New-construction at Soviet shipyards, too, receive machinery in part from abroad, particularly from Czechoslovakia and the German Democratic Republic (See Fig. 1).
3. Technological backwardness apparently exists in the USSR in the construction of high-power diesel engines.
4. Since 1959, the Danish firm of Burmeister & Wain has provided technical assistance and has conferred licenses for the duplication of their engine types at the Bryansk Enterprise.
5. Without Western assistance, the Soviet merchant fleet would exhibit only a fraction of its strength, since high-powered diesel engines would not be available.

The author's analysis, drawn on the basis of a thorough examination of Lloyd's Register as well as the Soviet ship register, including in particular evidence of new ship construction in the second half of the 1960s, is essentially still valid today.

The Soviet trade literature claims, to be sure, that maritime diesel engines were already being built in old Russia since 1903, and that pioneering efforts were accomplished in this area. Evaluation of all available ship- and machinery descriptions leads to the conclusion, however, that the Soviet maritime engine construction program and capacities are rather limited. A comparison of all engines employed in the Soviet Union makes clear that the performance limit for engines of domestic construction lies near 6,000 hp (see Table 1). Within this group are four types that should really be classified by wartime or pre-wartime standards. They are predominantly in-line engines

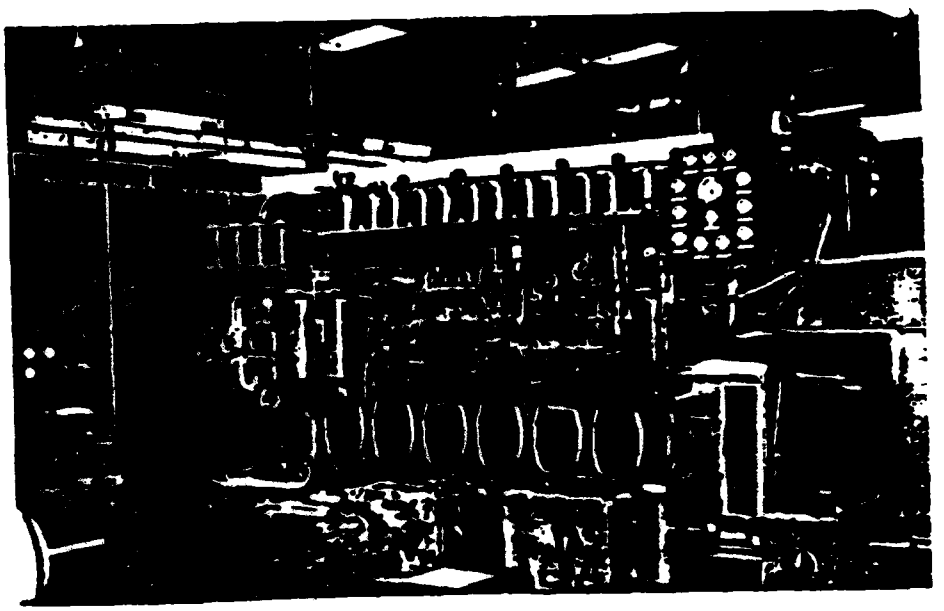

Fig. 1 Type 6VD26/20 AL-2 Diesel Engine (shown here in diesel generator version) of the "VEB Heavy Machinery Building Enterprise Karl Liebknecht" (SKL) in Magdeburg. The engine produces 662 kW at 1,000 1/min. Diesel enginges of the VD26/20 series (four-stroke in-line engines) are frequently used on board Soviet ships as the main machinery or as diesel generators.

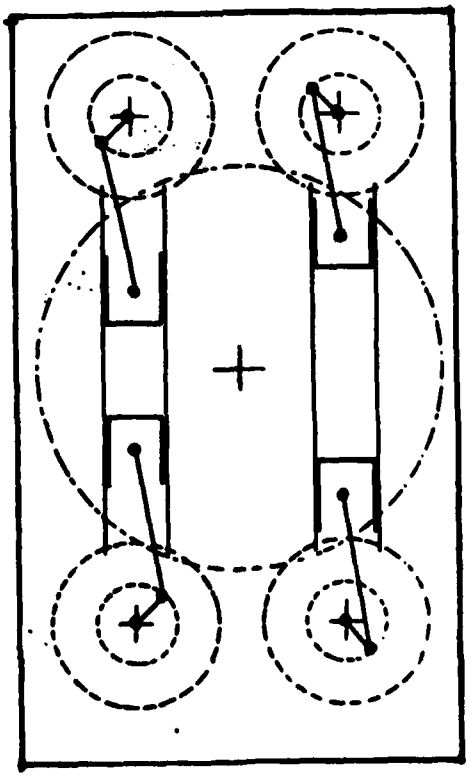

Fig. 2 Outline Sketch of the 58-D-3 Two-Stroke Counterpiston Diesel Engine.

Table 1 Soviet-Produced Maritime Diesel Engines.

Engine Type	Manufacturer	No. of Cyl.	Bore, mm	Stroke, mm	Rating, kW (hp)	Lenth, mm	Width, mm	Heigth, mm	RPM	Weight, tons	Remarks
8DR43/61	Russkiy Diesel	8	430	610	1,470 (2,000)	9,600	1,780	2,470	250	?	Two-stroke in-line, reversible
16DPN23/ 2x30 (58-D-3)	"	16	230	300	3,300 (4,500)	6,770	1,900	3,315	645	40.05	Two-stroke double in-line counter piston engine with integral gearbox.
16DPN23/ 2x30 (61-W-1)	"	16	230	300	4,400 (6,000)	6,770	1,900	3,315	850	40.05	
6TschRN 36/50 (G 74)	Gorki	6	360	500	1,100 (1,500)	7,170	1,470	2,840	?	?	Four-stroke in-line engine, reversible.
6TschPN 30/38 (2D42)	Gorki (?)	6	300	380	880 (1,200)	4,519	1,316	2,868	715	8.884	Four-stroke in-line engine, reversible.
56Tsch BSP16/17 (M-504)	Gorki (?)	56	160	170	3,676 (5,000)	4,400	1,650	1,640	1700	7.2	Four-stroke radial engine with added reversing gear.
12TschN 18/20 (M-401)	Gorki (?)	12	180	200	735 (1,000)	2,600	1,220	1,250	1,800	2.0	"
12DN23/ 30 (40 DM)	Kolomna	12	230	300	1,830 (2,500)	3,750	1,730	2,088	750	9.75	Two-stroke V-engine, reversible.
7DKRN80/ 160-4	Bryansk	7	800	1,600	12,350 (16,800)	13,855	3,960	11,800	122	585.0	Two-stroke cross-head engine, reversible, B&W license (7K80GF).
9DKRN80/ 160-4	"	9	800	1,600	15,880 (21,600)	16,555	3,960	11,800	122	725.0	See above. Matches B&W Type 9K80GF.

with low or medium rpms, and a high weight-to-performance ratio, rarely lightweight or V-shape engines, some mechanically-driven, and some with exhaust turbo-charging. Only a few types stand out for distinctive design characteristics. Among the four-stroke engines this includes a radial engine that is comprised of altogether 56 cylinders in eight blocks. This engine that has become known under the type designation M-504 is distinctive for an extremely low weight-to-performance ratio, and is especially adapted for the fast patrol boats of the navy. The M-401 type are likewise high-speed engines that were developed from the M-50 type of which several modifications are used primarily on hydrofoils. Among the two-stroke engines the Type 16 DPN 23/2x30 (also known as the 58-D-3, or 61-W-1) deserves mention. Two rows of cylinders are arrayed side-by-side in this diesel whose reciprocating pistons work on altogether four crankshafts. Power transmission is effected via a reduction gear that is built directly onto the engine housing. The non-reversible engine is ususally employed in tandem with controllable-pitch propellers as, for example, on the seagoing salvage tug "Jaguar" built at the Leningrad Admiralty yard. A different concept considers the employment of a torque converter.

Outside the performance boundaries cited, the Soviet Union has to resort to importation or else licensed production. Since the necessary machinery is also not available in the other countries of the Eastern block, the technical know-how is procured from the West, and, in fact, apparently according to a kind of division of labor: the German Democratic Republic has acquired license from M.A.N., the Poles from Sulzer, and later on likewise from M.A.N. and from Pielstick. Support for the Soviet Union has come via the already-mentioned cooperation with Burmeister & Wain.

The Bryansk engineworks used to copy chiefly low-performance engines, but this enterprise presently manufactures engines with a performance of over 20,000 hp. The BKRN-series of designs ordinarily includes low-speed engines that burn partially heavy fuel. They are reversible two-stroke crosshead machines as are generally used for the economical propulsion of merchant vessels.

The equipment of a large part of the Soviet merchant marine with engines that are produced under license from the aforementioned large corporations, and that match types that are distributed throughout the world, offers the additional advantage of a secure parts service and prompt repair.

Table 2 presents examples of Soviet new-construction and their propulsion machinery. Among large ships - the largest of the then-newly building tankers, too, receive diesel engines - the twostroke engines manufactured under license from B&W predominate. Smaller ships are fitted out with Soviet-produced or

Table 2 Examples of Propulsion Plants Used in Soviet New-Construction.

Ship Name	Ship Type	Building Yard	Load Capacity, tons deadweight	Propulsive power, kW	Speed, kt	Engine Type	Manufacturer	License
"Pobjeda"	Tanker	Kertsch	68,000	12,350	15.2	7DKRN 80/160-4	Bryansk	B&W
"Alexey Kosygin"	LASH carrier	Cherson	40,000	2x 12,350	18.4	7DKRN 80/160-4	"	"
"Soya Kosmodemjanskaya"	Bulk carrier	"Okean Nikolayev"	53,000	10,076	14.7	8DKRN 74/160-3	"	"
"Kapitan Sacharov"	Container ship	Vyborg	5,270	4,490	16.0	5DKRN 62/140-3	"	"
"Daurya"	Steel structure carrier	Volgograd	4,935	2x 1,100	11.3	DRA G 74	Gorki	---
"Dioroit"	Drillship	Jaroslawl	Displ. 970	970	12.5	8 NVD 48A-2U	SKL	---

alternatively with East German or Czechoslovakian engines. Ships completed on Soviet orders abroad in the West are generally fitted with foreign machinery. Accordingly, it can be claimed as a matter of fact and without exaggeration that the Soviet merchant marine would not show up in its present scope without the machinery equipment of such well-known corporations as Sulzer, M.A.N., Burmeister & Wain, Pielstick, and others. Interesting and significant is also a report from the Soviet trade press recently. The newly-built hydrofoil at the repair yard at Poti on the Black Sea, the "Kolchida," does not receive a domestically-produced propulsion arrangement, but two diesel engines (four-stroke, V-shape, 20 cylinders, 1,050 kilowatts/1,430 hp for 1,800 rpm) of the 12V396TC82 type of the MTU firm. The engines are encased for better noise proofing. Although engines of this order and magnitude are available from Soviet production, preference was given to a product from the Federal Republic of Germany.

Worth mentioning yet is the fact that the navy of the USSR with its large inventory of fast patrol boats, minesweepers, other small combatants as well as auxiliary and support vessels, has a need for maritime diesel engines that may run into several thousands of units.

Maritime Engine Construction in the USSR (See Fig. 3).

The construction of maritime diesel engines in the USSR is characterized by a striking concentration in a few enterprises (see also Table 1). The following specialization can be recognized: (43

1. The oldest engine works, "Russkiy Diesel" (formerly "Ludwig Nobel") located in the center of Leningrad on the Nabereshnaya Fokina on the bank of the Neva that is supposed to have produced maritime engines since 1903, appears to presently manufacture exclusively two-stroke engines, specifically medium-speed engines with a maximum output of up to 4,400 kilowatts (6,000 hp).
2. The Kolomna engine works, known as the manufacturer of engines for diesel locomotives, and engaged in the construction of maritime engines since 1908, also builds low-performance two-stroke engines.
3. The "Dwigatjel Revoluzij" enterprise ("Motor of the Revolution") in Gorki on the Volga is (presumably) the manufacturer of high-speed four-strike diesel engines with outputs up to 3,700 kilowatts (5,000 hp) that are particularly suited for fast surface craft such as hydrofoils, but also for the fast patrol boats of the navy.
4. The Bryansk enhine works have specialized exclusively in licensed construction, and deliver low-speed two-stroke diesel engines for large merchant vessels.

Other than these construction capabilities, compatible repair facilities for propulsion engines and diesel generators

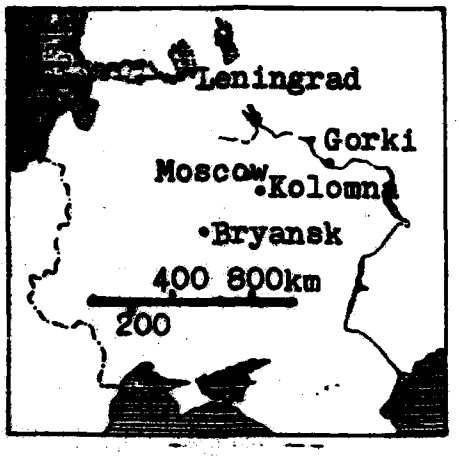

Fig. 3 Centres of Maritime Engine Construction in the USSR.

(including those of foreign origin) at the building yards must be assumed.

Gas Turbine Propulsion

Already in the 1960s, Soviet shipbuilders began to outfit some merchantships with gas turbines. The freighter "Pavlin Vinogradov" received a gas turbine with independent piston compressors that delivered 4,000 hp, and the ships "Leninskij Komosol" and "Parishkaja Kommuna" likewise gas turbine plants rated at 13,000 hp each. This GTU-20 type plant manufactured at the Kirov enterprise in Leningrad consists of two side-by-side turbines with the combustion chamber sitting on top (see Fig. 4). Operation of these earlier plants required reversible propellers. At the same time, the development of maritime gas turbine plants from navalized aircraft turbines and jet propulsion went ahead. AI-23 type gas turbines (1,750 hp) were installed in hydrofoils.

The GTU M-25 type turbine (see Fig. 5) represents an entirely new generation in the development of gas turbines. Its rating is almost twice that of the old GTU-20 for the same volume, namely 25,000 hp. It was developed for the fast Ro/Ro ships of the "Kapitan Smirnov" class built at Nikolajev, and represents a unique case from two perspectives: it does not require a controllable-pitch propeller to change the direction of the gasflow. Secondly, it is coupled with a steam turbine. The necessary steam is generated by the exhaust of the gas turbine. The exhaust boiler is mounted over the turbine, and delivers 26 tons of steam per hour with a temprature of 309 degrees Celcius, and a pressure of 11.4 kiloponds per square centimeter. The gas turbine delivers a maximum of 14,120 kilowatts (19,200 hp), and the steam turbine 4,270 kilowatts (5,800 hp).

The gas turbine proper consists of a seven-stage high-pressure- and a one-stage low-pressure compressor, the combust-

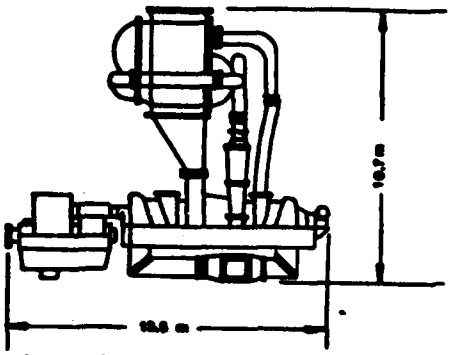

Fig. 4 Type GTU-20 Gas Turbine Layout.

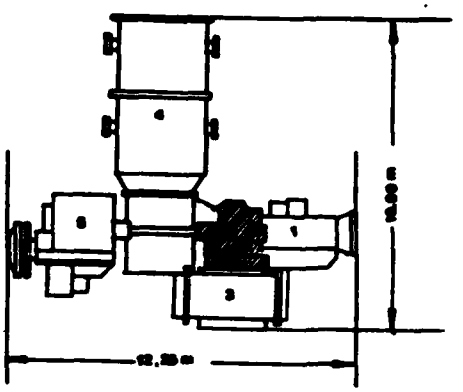

Fig. 5 Type GTU M-25 Gas Turbine Layout. 1. Gas turbine, 2. Steam turbine, 3. Condensator, 4. Exhaust boiler, 5. Drive mechanism.

ion chamber, a two-stage high-pressure-, a two-stage low-pressure-, and a reversible power turbine. The reduction gear is a dual gear arrangement with integral clutches. The steam turbine is de-coupled periodically, e.g. during reversing maneuvers. The steam is then led directly to the condensor via a bypass conduit. Installed, the entire plant weighs 150 tons.

When there is no need for high speeds, exceptionally economical operations can be achieved through the following measures:

1. Possibility: only one unit of the twin-propeller ship is placed in operation while the other propeller either idles or is secured.
2. Possibility: one gas turbine is operational and powers its own shaft directly. Steam from the exhaust boiler is fed from the steam turbine to the other shaft, so that both propellers operate. (45

At full plant capacity, the approximately 14,000 gross tonnage Ro/Ro ships develop a speed of 22 knots. Fuel consumption under favorable conditions supposedly lies at 175 grams per brake horsepower.

Summary Evaluation

From the totality of usable evidence concerning the technological status of Soviet maritime machinery construction, the following conclusions can be drawn and prognoses for its further development made:

1. Soviet industry meets international standards in the construction of conventional steam propulsion plants. Even though steam turbine propulsion is losing importance in the merchant marine, it cannot be ruled out in naval construction. In any case, Soviet new-construction aircraft carriers will eventually be fitted with steamplants.
2. Soviet nuclear propulsion plants seem to be well-established since their application in the icebreaker "Lenin." Also in the naval sphere, much practical experience is available with the operations of nuclear submarines.

3. In the area of gas turbine construction, the USSR is considered especially advanced. Operational experience in this area has been accumulated primarily in the naval arena, but this should nevertheless prove advantageous for the merchant marine as well.
4. Surprising is the obvious technological backwardness in the construction of diesel engines. Here, the oft-cited West-East technology transfer has occurred in a noticeable fashion. Further Soviet efforts of this sort are to be counted on.
5. Noticeable are efforts of the USSR, in spite of its position as the largest oil producer in the world, to yet use its petroleum reserves economically. The utilization of atomic energy for ship propulsion is probably to be seen as an aspect of overall energy economics.

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4. Magazines Sudostroyenye, Morskoj Flot, and Soviet Shipping, various years of issue.

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12DN23/ 30 (40 DM)	Kolomna	12	230	300	1,830 (2,500)	3,750	1,730	2,088	750	9.75	Two-stroke V-engine, reversible.
7DKRN80/ 160-4	Bryansk	7	800	1,600	12,350 (16,800)	13,855	3,960	11,800	122	585.0	Two-stroke cross-head engine, reversible, B&W license (7K80GF).
9DKRN80/ 160-4	"	9	800	1,600	15,880 (21,600)	16,555	3,960	11,800	122	725.0	See above. Matches B&W Type 9K80GF.

Reston, October 25, 1983.

Ms. Mary Hannah, NISC-62,
NIC Headquarters Building #1,
Room 138,
Washington, DC, 20389.

Dear Ms. Hannah,

Enclosed is my translation of "Sowjetische Schiffsantrieb-anlagen," including the original plus two xerox copies. I have also enclosed the original to Table 1 which required reduction in order to fit the page size. I hope that this work meets your professional requirements.

Did not return original request.

Sincerely,

Jan S. Breemer

11218 Fairway Drive,
Reston, VA, 22090.

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